

REMARKS/ARGUMENTS

Claims 12-17 and 24-29 are pending in this Application.

The Examiner is reminded that in an Information Disclosure Statement filed on July 9, 2010 that Applicant cited co-pending U.S. Patent Application No. 12/829,413 to bring to the attention of the Examiner and have the Examiner consider the subject matter and claims of the co-pending U.S. Patent Application, the prior art references, Office Actions, and Applicant's responses to the Office Actions made of record in the co-pending U.S. Patent Application. Applicant respectfully requests that the Examiner update his review and consideration of the claims of the co-pending U.S. Patent Application, the prior art references, Office Actions, and Applicant's responses to the Office Actions made of record in the co-pending U.S. Patent Application.

Applicant's counsel greatly appreciates the courtesies extended by the Examiner in the telephone interviews of October 28 and November 1, 2010. The Examiner agreed that Applicant's specification supports the feature of "the brazing foil being composed of a Cu-Ni alloy essentially comprising not less than about 17 mass% and not greater than about 20 mass% of Ni" as recited in Applicant's claim 12 and as similarly recited in Applicant's claim 24. The Examiner also agreed that the translation of Hasegawa et al. (JP 2003-145290) that was relied on in the prior art rejections was incorrect and agreed to obtain a new translation.

At the end of the interview on November 1, 2010, the Examiner alleged that EP 1 068 924 teaches a Cu-Ni alloy with 20wt% of Ni, for example, in col. 9 and l. 4 and col. 10, l. 39. However, the Examiner failed to address the other features recited in Applicant's claims 12 and 24 or explain how or why this alleged teaching of EP 1 068 924 could be combined with the teachings of the other prior art references relied on to reject Applicant's claims. Further, EP 1 068 924 correspond to JP 3350667 B, which is discussed in paragraph [0004] of Applicant's substitute specification.

The Examiner rejected claims 12-17 and 24-29 under 35 U.S.C. § 112, first paragraph as allegedly containing subject matter that was not described in the specification in such a way as

to reasonably convey to one skill in the relevant art that the inventors, at the time of the application was filed, had possession of the claimed invention.

In the Amendment filed June 4, 2010, Applicant amended claim 12 to recite the feature of "the brazing ~~material~~-foil being composed of a Cu-Ni alloy essentially comprising not less than about ~~10-17~~ mass% and not greater than about 20 mass% of Ni." Applicant amended claim 24 in a similar manner.

The Examiner alleged that Applicant's substitute specification does not support "not less than about 17 mass%" and that Table 1 of Applicant's substitute specification only provides support for "exactly" 17 mass%.

Paragraph [0033] of Applicant's substitute specification in combination with Samples Nos. 2-5 in Table 1 on page 24 of Applicant's substitute specification provides support for "not less than about 17 mass%." Paragraph [0033] of Applicant's substitute specification states, "The brazing material layer 14 is preferably composed of a Cu-Ni alloy essentially including Ni in a proportion of not smaller than about 10% and not greater than about 20%."

The first paragraph of MPEP § 2163.05(III) states:

With respect to changing numerical range limitations, the analysis must take into account which ranges one skilled in the art would consider inherently supported by the discussion in the original disclosure. In the decision in *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976), the ranges described in the original specification included a range of "25%-60%" and specific examples of "36%" and "50%." A corresponding new claim limitation to "at least 35%" did not meet the description requirement because the phrase "at least" had no upper limit and caused the claim to read literally on embodiments outside the "25% to 60%" range, however a limitation to "between 35% and 60%" did meet the description requirement.

Just as Wertheim's disclosure of "a range of 25%-60%" and the specific examples of "36%" and "50%" supports "a range of 35% and 60%," so too does Applicant's disclosure of a range of "not smaller than about 10% and not greater than about 20%" and a specific example of "17%" supports the range of "not less than about 17 mass% and not greater than about 20 mass% of Ni" as recited in Applicant's claim 12 and as similarly recited in Applicant's claims 24.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection of claims 12-17 and 24-29 under 35 U.S.C. § 112, first paragraph.

On page 3 of the outstanding Office Action, the Examiner rejected claims 12-15 and 25-27 under 35 U.S.C. § 103(a) as being unpatentable over Hasegawa et al. (JP 2003-145290) in view of Yasui et al. (U.S. 5,289,965). On page 8 of the Office Action, the Examiner rejected claims 24-27 under 35 U.S.C. § 103(a) as being unpatentable over Hasegawa et al. On page 8 of the Office Action, the Examiner rejected claims 16, 17, 28, and 29 under 35 U.S.C. § 103(a) as being unpatentable over Hasegawa et al. and Yasui et al. and in further view of Ishio et al. (EP 1 068 924).

Applicant respectfully traverses the rejection of claims 12-17 and 24-29.

Applicant's claim 12 recites:

A brazing method for brazing a first member and a second member to be joined via a braze joint, the method comprising the steps of:

preparing the first member and a brazing foil, the first member including a base plate composed of a ferrous material and a diffusion suppressing layer laminated on the base plate for suppressing diffusion of Fe atoms into the braze joint from the base plate during the brazing, the diffusion suppressing layer being composed of a Ni-Cr alloy essentially comprising not less than about 15 mass% and not greater than about 40 mass% of Cr, **the brazing foil being composed of a Cu-Ni alloy essentially comprising not less than about 17 mass% and not greater than about 20 mass% of Ni;**

assembling the first and second members into a temporary assembly with the brazing foil disposed between the diffusion suppressing layer of the first member and the second member;

performing a brazing process by maintaining the temporary assembly at a brazing temperature of not less than about 1,200°C to fuse the brazing foil and diffuse Ni atoms and Cr atoms into the fused brazing foil from the diffusion suppressing layer to form the braze joint, causing the resulting brazing material of the braze joint to have a higher melting point than the brazing temperature to self-solidify all of the brazing material of the braze joint, wherein the braze joint is free from segregated solidification and is composed of a Cu-Ni-Cr alloy comprising not less than about 34 mass% of Ni and not less than about 10 mass% of Cr; and

cooling the resulting assembly. (emphasis added)

Applicant's claim 24 recites features that are similar to the above emphasized features recited in Applicant's claim 12.

The Examiner alleged that paragraph [0011] of Hasegawa et al. teaches the feature of "the brazing foil being composed of a Cu-Ni alloy essentially comprising not less than about 17 mass% and not greater than about 20 mass% of Ni" recited in Applicant's claim 12 and as similarly recited in Applicant's claim 24. Applicant's claim 24 recites "brazing material layer" instead of "brazing foil."

Applicant respectfully disagrees because the Examiner has based this allegation on portions of Hasegawa that were incorrectly translated.

In Applicant's specification, "a brazing foil" as recited in Applicant's claim 12, and "brazing material layer" as recited in Applicant's claim 24, is made of a brazing material equal to a brazing filler metal before brazing.

"A braze joint" as recited in Applicant's claims 12 and 24 is formed by fusing the brazing foil or the brazing material layer and diffused Ni atoms and Cr atoms into the fused brazing foil or the brazing material layer while brazing and solidified after brazing, as explained, for example, Applicant's claim 12 or 24 and paragraph [0009] of Applicant's substitute specification. That is, "a braze joint" recited in Applicant's claims 12 and 24 refers to a brazed part after brazing.

The English translation of Hasegawa et al. relied upon by the Examiner confuses these two terms. The Japanese term "(CU系)ろう材" (read as "(Cu kei) rouzai" in Japanese) used in Hasegawa et al. is translated as "a (Cu-based or Cu) brazing filler metal" that most closely corresponds to the brazing material of the brazing foil or the brazing material layer as recited in Applicant's claims 12 and 24.

The Japanese term "ろう材部" (read as "rouzai-bu" in Japanese) used in Hasegawa et al. is translated as "a brazing filler metal part" that most closely corresponds to the braze joint as recited in Applicant's claims 12 and 24.

The English translation of Hasegawa et al. that the Examiner has relied upon confuses “(Cu系)ろう材” (“a (Cu-based or Cu) brazing filler metal”) and “ろう材部” (“a brazing filler metal part”).

A brazing filler metal part as used in Hasegawa et al. clearly means a braze joint, as explained in paragraph [0011] of Hasegawa et al. Further, paragraphs [0006] and [0007] of Hasegawa et al. further explain that the brazing filler metal part corresponds to the braze joint.

The “Means for Solving the Problem” section (paragraphs [0006]-[0015], including paragraph [0011] that the Examiner relied upon) of Hasegawa et al. includes numerous translations errors. Applicant has prepared two marked-up documents that show the locations of the translations errors.

The first document is the Japanese language Hasegawa et al. in which all instances of “(Cu系)ろう材” and “ろう材部” are accompanied with a reference number 1-25. The instances of “(Cu系)ろう材” are boxed with rectangles, and the instances of “ろう材部” are underlined.

The second document is the English translation of Hasegawa et al. in which the same reference numbers, underlines, and rectangular boxes are included but with respect to the translated English terms corresponding to “(Cu系)ろう材” and “ろう材部.”

Comparing the Japanese terms with the corresponding English terms with the same reference number reveals the mistakes in the English translation of Hasegawa et al.

All of the translated English terms in paragraphs [0006]-[0009] of Hasegawa et al. are correct. However, there are many mistakenly translated English terms in paragraphs [0010]-[0015]. Specifically the English terms with reference numbers 14, 15, 17, 19, 20, 21, 22, and 25 are incorrectly translated. There are three instances of “ろう材部” in paragraph [0011] of Japanese language version of Hasegawa et al., but there is only one instance (reference number 16) of “the brazing filler metal part” in the English translation of Hasegawa et al. Two instances (reference numbers 15 and 17) of “the brazing filler metal” in the English translation of Hasegawa et al. are incorrectly translated. Reference numbers 15 and 17 should have been translated as “the brazing filler metal part.”

Therefore, the feature of the brazing foil (brazing material layer) being composed of a Cu-Ni alloy essentially comprising not less than about 17 mass% and not greater than about 20 mass% of Ni as recited in Applicant's claims 12 and 24 is not taught or suggested in paragraph [0011] of Hasegawa et al. or in any other paragraph of Hasegawa et al. Lines 5-7 of paragraph [0021] of English translation of Hasegawa et al. clearly describe that a Cu-Ni alloy used as a brazing filler metal "should contain 15% or less of Ni with the basic element of Cu for the balance."

Further, the brazing filler metal part discussed in paragraph [0011] of the English translation of Hasegawa et al. that the Examiner indicated is composed of a Cu-Ni-Cr alloy having a Cr content of 10-15% is different from the Cu-Ni alloy of which the brazing foil or brazing material layer of Applicant's claimed invention is composed.

Thus, Hasegawa et al. fails to teach or suggest the feature of "the brazing foil being composed of a Cu-Ni alloy essentially comprising not less than about 17 mass% and not greater than about 20 mass% of Ni" as recited in Applicant's claim 12.

In § 11 of the Office Action, the Examiner alleged:

In response to the applicant's argument that specimen 12 of Hasegawa does not achieve the claimed lower limit of 34%, is an unacceptable joint because it receives a C grade and is not self-solidified, while these statements may be true they do not hold true for the entire ranges taught by Hasegawa. The specimens taught in Table 1 are but a fraction of the possibilities that could lie within the ranges taught by Hasegawa. Therefore, saying that the properties of a single example are indicative of the entire genus is neither proper nor persuasive.

However, the deterioration of the corrosion resistance is not limited to Sample No. 12 of Hasegawa et al. As explained in lines 8-14 of paragraph [0007], lines 11 and 12 of paragraph [0011], lines 1-3 of paragraph [0013], and lines 1-4 of paragraph [0019] of Hasegawa et al., the corrosion resistance deteriorates when the Ni content of the brazing filler metal part is above 25%.

Further, lines 1-4 in paragraph [0019] of the English translation of Hasegawa et al. are incorrectly translated. The correct translation of this portion of Hasegawa et al. is: "Said Ni-Cr

alloy improves the corrosion resistance of the brazing filler metal part since about 15-~~15~~25% of Ni is diffuses and solid-solves into the brazing filler metal part as formed by melting of the brazing filler metal layer 13 melts-during the brazing process.” The “Said Ni-Cr alloy” is a Ni-Cr alloy of the Fe-atom-diffusion-suppressing layer 12. No portion of Hasegawa et al. teaches that the brazing filler metal part has excellent corrosion resistance when the brazing filler metal part has a Ni content over 25%.

The Examiner has relied upon Yasui et al. and Ishio et al. to allegedly cure various deficiencies in Hasegawa et al. However, Yasui et al. and Ishio et al., applied alone or in combination with, fail to teach or suggest the feature of “the brazing foil being composed of a Cu-Ni alloy essentially comprising not less than about 17 mass% and not greater than about 20 mass% of Ni” in combination with the other features recited in Applicant’s claims 12 and 24.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection of claim 12 under 35 U.S.C. § 103(a) as being unpatentable over Hasegawa et al. in view of Yasui et al. and the rejection of claim 24 under 35 U.S.C. § 103(a) as being unpatentable over Hasegawa et al.

Accordingly, Applicant respectfully submits that the prior art of record, applied alone or in combination, fails to teach or suggest the unique combination and arrangement of elements recited in claims 12 and 24 of the present application. Claims 13-17 and 25-29 depend upon claims 12 and 24 and are therefore allowable for at least the reasons that claims 12 and 24 are allowable.

In view of the foregoing remarks, Applicant respectfully submits that this application is in condition for allowance. Favorable consideration and prompt allowance are solicited.

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Reply to the Office Action dated August 5, 2010

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The Commissioner is authorized to charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 50-1353.

Respectfully submitted,

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て不十分であり、また熱交換器を組み込んだ処理システム全体にとって悪影響があることがわかった。すなわち、排ガスなどの熱交換すべき流体が高温腐食性流体である場合、ろう材部の耐酸化性が不足すると、ろう材部の酸化減耗により接合強度の劣化が生じるばかりでなく、酸化皮膜がろう材部の表面から剥離して熱交換器の下流側へ流れて行き、下流側に設けられた各種の処理装置を汚損し、その性能を劣化させるという問題が判明した。

【0005】本発明はかかる問題に鑑みなされたもので、熱交換器の流路構造等のろう接構造において、そのろう材部に優れた耐食性および耐酸化性を付与することができるろう接用材料、およびろう材部における耐食性および耐酸化性に優れたろう接構造を提供することを目的とするものである。

【0006】

【課題を解決するための手段】本発明によるろう接用複合材は、耐食性鋼材により形成された基板と、前記基板の表面に積層形成され、純CuあるいはCuを主成分とするCu基合金で形成されたCu系ろう材¹によって接合部材をろう接する際に前記基板からFe原子がろう材側に拡散するのを抑制するFe原子拡散抑制層とを備え、前記Fe原子拡散抑制層はNiを主成分とし、Cr:10~30mass%を含有するNi-Cr合金で形成されたものである。以下、成分の単位は単に%で表示する。

【0007】この複合材によれば、基板にはFe原子拡散抑制層が積層形成されているので、この複合材を用いてろう接したろう接構造物におけるろう材部には、ろう接の際に基板からFe原子がろう材部に拡散することがFe原子拡散抑制層によって防止され、ろう材部の耐食性の劣化を防止することができる。さらに、Fe原子拡散抑制層はCrを所定量含むNi-Cr合金で形成されているので、ろう接の際にFe原子拡散抑制層からNi、Crをろう材部に拡散させることによって、ろう材部に15~25%のNi、10~15%のCrを含有したCu-Ni-Cr合金を形成することができる。前記Cu-Ni-Cr合金のNiはろう材部の耐食性をより一層向上させ、前記Crはろう材部の表面にCr系酸化膜を形成して、耐酸化性を向上させる。このため、ろう接構造のろう材部²に耐食性および耐酸化性に優れたもの³とすることができる。

【0008】前記ろう接用複合材の好ましい態様として、前記Fe原子拡散抑制層の上に前記Cu系ろう材⁴によって形成されたろう材層⁵を積層形成することができる。ろう材層を一体的に設けることにより、接合部材をろう接する際に、別途にろう材⁶を準備する必要がなく、ろう接作業性を向上させることができる。

【0009】また、前記ろう接用複合材の好ましい態様として、Cu系ろう材⁷をCuを主成分とし、Al:1~7%を含有するCu基合金⁸で形成することができる。か

かるAl含有Cu基合金を用いることにより、Al系酸化膜がCr系酸化膜の下側に形成され、2重の酸化膜により耐酸化性を著しく向上させることができる。

【0010】前記ろう接用複合材におけるFe原子拡散抑制層は、5μm以上の厚さとすることが好ましい。5μm以上の厚さとすることで、ろう接の際に基板のFe原子がFe原子拡散抑制層を固相拡散してろう材部に侵入するのを十分に抑制することができ、ろう材部のFe原子の拡散侵入による耐食性の劣化を十分に防止することができる。

【0011】本発明によるろう接構造は、耐食性鋼材で形成された基板を有する第1接合部材と、耐食性鋼材で形成された基板を有し、前記第1接合部材にろう材部⁹を介してろう接された第2接合部材とを備え、前記第1接合部材は前記第2接合部材がろう接される際に前記第1接合部材の基板からFe原子がろう材部に拡散するのを抑制するFe原子拡散抑制層を有し、このFe原子拡散抑制層はNiを主成分とし、Cr:10~30mass%を含有するNi-Cr合金で形成され、前記ろう材部はCuを主成分とし、Ni:15~25%、Cr:10~17.5%を含有するCu-Ni-Cr合金で形成される。

【0012】このろう接構造によれば、第1接合部材は基板に必須成分としてCrを含むNi-Cr合金で形成されたFe原子拡散抑制層が形成されているので、第2接合部材をろう接する際に、第1接合部材の基板からFe原子がろう材部に拡散侵入することを抑制することができ、さらにFe原子拡散抑制層からのNi、Crの拡散によって形成された所定量のNiによる合金化と、所定量のCrによるCr系酸化膜の形成により、ろう材部に優れた耐食性と耐酸化性とが付与される。これによって、ろう接構造は優れた耐久性を備えたものとなる。

【0013】前記ろう接構造において、そのろう材部はCuを主成分とし、Ni:15~25%、Cr:8~15%、Al:1~5%を含有するCu-Ni-Cr-Al合金で形成することが好ましい。ろう材部に所定量のAlを含有させておくことで、Al酸化膜をCr系酸化膜の下側に複合形成することができ、耐酸化性をより向上させることができる。ろう材部に所定量のAlを含めるには、ろう接に用いるCu系ろう材¹⁰として、Alを1~5%含有し、Cuを主成分とするAl添加Cu基合金を用いればよい。

【0014】前記ろう接構造において、前記第1接合部材と前記第2接合部材との間にこれらの接合部材によって区画された流路を形成することができる。かかる流路を形成することにより、この流路に熱交換される流体あるいは熱交換する媒体を流すことができ、優れた耐久性を備えた熱交換器の流路構造を提供することができる。また、前記流路の下流側に付設される装置に対して酸化皮膜の剥離による悪影響を防止することができる。

【0015】また、前記ろう接構造において、前記第2

部材も前記第1接合部材と同様、前記第1接合部材と第2接合部材とがろう接される際に前記第2接合部材の基板からFe原子がろう材部に拡散するのを抑制するFe原子拡散抑制層を設け、このFe原子拡散抑制層を前記Ni-Cr合金によって形成することができる。これによって、第2接合部材からろう材部にFe原子が拡散侵入するのを防止することができ、また第2接合部材のろう接性を向上することができる。

【0016】

【発明の実施の形態】図1は本発明の実施形態にかかるろう接用複合材1を示しており、プレート状の基板11の片面にFe原子拡散抑制層12が積層形成され、その上にろう材層13が積層形成されている。このろう接用複合材1は、Fe原子拡散抑制層12の上にろう材層13が積層形成されているので、ろう接作業を行う際に、別途準備したろう材をろう接の対象である接合部材の間に付設するといった煩雑な作業が不要となり、ろう接作業性に優れる。

【0017】前記基板11は、耐食性の良好な鉄鋼材、例えばJIS規格のSUS304、SUS316等のオーステナイト系ステンレス鋼材、SUS430、SUS434等のフェライト系ステンレス鋼材などのステンレス鋼材で形成される。

【0018】前記Fe原子拡散抑制層12は、Cr:10~30%、好ましくはCr:15~25%、残部Niを本質的成分とするNi-Cr合金で形成される。このNi-Cr合金は、Feを含まず、その融点がろう材層13を形成するCu系ろう材の融点よりも高く、NiおよびCrが前記ろう材の主成分であるCuと固溶し、従って腐食の起点になりやすい析出物を生成しないものである。前記Ni-Cr合金は、典型的には本発明において重要成分であるCrのほか、残部Niおよび不可避免的な不純物元素からなるが、Niに固溶し、Ni-Cr合金としての加工性を損なわず、ろう接後のろう材部の特性を劣化させない元素であれば、その微量添加は許容される。

【0019】前記Ni-Cr合金のNiはろう接の際にろう材層13の溶融により生じたろう材部に15~25%程度拡散させて固溶させることにより、ろう材部の耐食性を向上させる。一方、Crは前記ろう材部に10~15%拡散させて固溶させることにより、その表面にCr系酸化膜を形成するようになるため、耐酸化性を向上させる。前記Ni-Cr合金のCr含有量が10%未満ではろう接の際にろう材部に前記適量のCrの拡散が困難であり、ろう材部の耐酸化性が低下するようになる。一方、30%を超えると加工性が劣化し、ろう材部への拡散が過多となる。その結果、ろう材部におけるCr量が15%超になり、Crの偏析が生じ易くなり、耐食性が却って低下するようになる。このため、Fe原子拡散抑制層12を形成するNi-Cr合金のCr含有量を1

0~30%、好ましくは10~25%、より好ましくは15~25%とする。

【0020】前記Fe原子拡散抑制層12の厚さは、5μm以上、好ましくは8μm以上、より好ましくは10μm以上とするのがよい。前記ろう接用複合材を用いて、ろう接する場合、ろう接温度は後述するように1100~1250℃程度とされるが、かかる高温でのろう接によっても、5μm程度の厚さがあれば相当程度のFe原子の拡散抑制効果を得ることができ、10μmもあればほぼ完全にFe原子のろう材部への拡散を防止することができる。

【0021】前記ろう材層13としては、純CuあるいはCuを主成分とするCu基合金からなるCu系ろう材によって形成される。前記Cu基合金としては、構成成分が完全に固溶状態をなす、例えばCu-Ni合金、Cu-Mn-Ni合金を用いることができる。Cu含有量は、概ね85%程度以上あればよい。前記Cu-Ni合金では、Ni:15%以下、残部Cuを本質的成分とする組成が好ましい。Niが15%超になるとろう材の融点が高くなり、ろう接作業が困難になる。前記Cu基合金には、Cuに固溶し、ろう材の加工性、ろう接後のろう材部の特性を損なわない元素であれば、その微量添加は許容される。

【0022】前記Cu系ろう材は、特にAlが1~5%、好ましくは2~4%添加されたAl添加Cu基合金が好ましい。Alを添加することによって、ろう接によって形成されたろう材部の表面に形成されたCr系酸化膜の下側(ろう材側)にさらにAl系酸化膜が形成されるようになり、2重の酸化膜が形成されるため耐酸化性が著しく向上する。Al量が1%未満ではAl系酸化膜の形成が困難であり、一方5%を超えるとAl添加Cu基合金の加工が困難となり、ろう材として使用できないようになる。Al添加Cu基合金をろう材として用いる場合、Alの作用により耐酸化性が大幅に向上するので、ろう材部におけるCr含有量を8~15%とすることで十分な耐酸化性を得ることができる。なお、前記Cr系酸化膜やAl系酸化膜は、EPMAによって確認することができる。

【0023】前記基板11へのFe原子拡散抑制層12の積層形成には、一般的には圧接によるクラッド法が適用されるが、めっき、溶射、PVD、CVDなどの種々の方法を適用することもできる。基板11とFe原子拡散抑制層12とを圧接によってクラッドすれば、めっきの場合に問題となるピンホールが生じることもなく、両者を容易に一体化することができ、工業的生産性に優れる。また、圧接の際の圧下率を調整するだけでFe原子拡散抑制層12の厚さも容易に制御することができる。ろう材層13は、通常、基板11に積層されたFe原子拡散抑制層12の上に圧接により接合される。3層を圧接によりクラッドする場合、基板11、Fe原子拡散抑

COMPOSITE MATERIAL FOR BRAZING AND BRAZING STRUCTURE
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corrosion resistance of the brazing filler metal is not sufficient to obtain durability and that it would adversely affect the overall processing system mounted with the heat exchanger. In other words, when the fluid, such as exhaust gas, to be heat exchanged is high-temperature corrosive fluid, insufficient oxidation resistance of the brazing filler metal would not only cause deterioration of bonding strength due to oxidation depletion of the brazing filler metal, but also it would cause the oxide layer to peel off from the surface of the brazing filler metal and to flow to downstream side of the heat exchanger, contaminating and damaging various processing devices located in the downstream side, and the performance would suffer.

[0005] This invention addresses these problems and aims to provide material for brazing that can add excellent corrosion resistance and oxidation resistance to the brazing filler metal part, to be used in the brazed structure of flow passage structure of heat exchanger and the like, as well as to provide brazed structure with excellent corrosion resistance and oxidation resistance in the brazing filler metal part.

[0006] [Means for solving the problem]

The composite material for brazing of this invention comprises a base plate made from corrosion resistant steel material and has Fe-atom-diffusion-suppressing layer laminated on the surface of said base plate for suppressing diffusion of Fe atoms from said base plate to the brazing filler metal side when joining member is brazed with Cu-based brazing filler metal of pure Cu or Cu-group alloy having Cu as the main element. Here, said Fe-atom-diffusion-suppressing layer is formed from

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Ni-Cr alloy with chief ingredient of Ni and containing 10-30 mass % of Cr. From here on, components will be expressed with simple %.

[0007] With this composite material, since the base plate has laminated Fe-atom-diffusion-suppressing layer, the brazing filler metal 2 part of brazed structure using this composite material would be protected by Fe-atom-diffusion-suppressing layer which suppresses Fe atoms from diffusing from the base plate to the brazing filler metal part 3 during brazing process. This would prevent deterioration in the corrosion resistance characteristics of the brazing filler metal part 4, since the Fe-atom-diffusion-suppressing layer is formed from Ni-Cr alloy containing prescribed amount of Cr, its Ni and Cr would diffuse from the Fe-atom-diffusion-suppressing layer to the brazing filler metal part 5 during the brazing process, which can form Cu-Ni-Cr alloy, containing 15-25% of Ni and 10-15% of Cr, in the brazing filler metal part 6. Said Cu-Ni-Cr alloy can further improve the corrosion resistance of the brazing filler metal part 7, and said Cr forms Cr oxidized film on the surface of the brazing filler metal part 8, improving its oxidation resistance. For this reason, it is possible to provide excellent corrosion resistance and oxidation resistance to the brazing filler metal part of the brazed structure. 9

[0008] One of favorable feature of said composite material for brazing is that it is possible to laminate the brazing filler metal 10A layer created from said Cu brazing filler metal 10 on top of said Fe-atom-diffusion-suppressing layer. By integrating the brazing filler metal layer, there is no need to prepare separate brazing filler metal 11

during brazing the joining member, and can improve the workability of brazing process.

[0009] Further, one favorable aspect of said composite material for brazing is that it is possible to form the Cu brazing filler metal 12 from the Cu-group alloy with the main ingredient of Cu and containing 1-7% of Al. By using such Cu-group alloy containing Al, an Al oxidized film is formed in the lower side of the Cr oxidized film. This double layer of oxidized films can significantly improve the corrosion resistance.

[0010] It is better to make the thickness of the Fe-atom-diffusion-suppressing layer of said composite material for brazing at least 5 μ m or more. With 5 μ m or more thickness, it is possible to sufficiently suppress Fe atoms of the base plate to invade the brazing filler metal part 13 through solid-phase diffusion of the Fe-atom-diffusion suppressing layer, and to sufficiently prevent deterioration of corrosion resistance due to diffusion and invasion of Fe atoms into the brazing filler metal 14.

[0011] The brazing structure of this invention comprises the first joining member having a base plate formed from corrosion resistant steel material and a second joining member having a base plate formed from corrosion resistant steel material and brazed to said first joining member via the brazing filler metal 15, where said first joining member has a Fe-atom-diffusion-suppressing layer which suppresses Fe atoms to diffuse from the base plate of the first joining member to the brazing filler metal part 16 when the second joining member is brazed, wherein the Fe-atom-diffusion-suppressing layer is formed from Ni-Cr alloy having

Ni as the chief ingredient and containing 10-30 mass % of Cr, wherein the brazing filler metal ¹⁷ is formed from Cu-Ni-Cr alloy having Cu as the chief ingredient and containing 15-25 % of Ni, and 10-15 % of Cr.

[0012] With this brazing structure, the first joining member is formed from the base plate laminated with Fe-atom-diffusion-suppressing layer of Ni-Cr alloy containing the essential ingredient of Cr. Thus, when the second joining member is brazed, it is possible to suppress the Fe atoms in the baseplate of the first joining member from diffusing and invading the brazing filler metal part. ¹⁸ Further, diffusion of Ni and Cr from the Fe-atom-diffusion-suppressing layer would create alloy from prescribed amount of Ni and created Cr oxidized film from prescribed amount of Cr. This would add excellent corrosion resistance and oxidation resistance to the brazing filler metal. ¹⁹ Thus, the brazing structure would possess an excellent durability.

[0013] In said brazing structure, the brazing filler metal ²⁰ should be formed from Cu-Ni-Cr-Al alloy having Cu as its main ingredient and containing 15-25% of Ni, 8-15% of Cr, and 1-5% of Al. By including prescribed amount of Al in the brazing filler metal, ²¹ it is possible to form compound Al oxidized film below Cr oxidized film, which would further improve the oxidation resistance. In order to include prescribed amount of Al in the brazing filler metal, ²² one should use Cu-group alloy with chief ingredient of Cu with Al additive, ²³ containing 1-5% of Al, for Cu brazing filler metal used for brazing.

[0014] In above-mentioned brazing structure, it is possible to form a flow passage between said first joining member and second joining member

from these joining member materials. By forming such flow passage, it is possible to flow the fluid to be heat exchanged or medium to be heat exchanged in this flow passage, providing flow passage structure of heat exchanger with excellent durability. Further, it is possible to prevent adverse effect from peeled oxidized film on the devices deployed in the downstream side of the flow passage.

[0015] In above-mentioned brazing structure, said second joining member, just like said first joining member, could have a Fe-atom-diffusion suppressing layer which suppresses Fe atoms from diffusing to the brazing filler metal part ²⁴ from the base plate of the second joining member when the first joining member and the second joining members are brazed. This Fe-atom-diffusion-suppressing layer could be made from said Ni-Cr alloy. With this, it is possible to prevent Fe atoms from the second joining member ²⁵ to diffuse and invade the brazing filler metal, and can improve the performance of brazing of the second joining member.

[0016] [Embodiments]

Figure 1 shows a composite material for brazing 1 under one embodiment of this invention, where a Fe-atom-diffusion-suppressing layer 12 is laminated on one side of the base plate 11 in a plate shape, and the brazing filler metal layer 13 is laminated on top of it. Since this composite material for brazing has a brazing filler metal layer 13 laminated on top of the Fe-atom-diffusion-suppressing layer 12, it is not necessary to take additional step to add separately prepared brazing filler metal between the target joining member materials during the brazing process. This would provide an excellent workability of brazing process.